

Exercises

3. The train could have stopped on a banked section of track, or worse, derailed and ended up leaning against an embankment. Or perhaps some now fashionable aliens with a chunk of superdense matter have landed next to the train, attracting its occupants to one side. By the principle of equivalence, gravity can duplicate the effects of acceleration.

8. The separation distance of two people walking north from the Earth's equator decreases, and if they continue to the north pole their separation distance will be zero. At the north pole, a step in any direction is a step south!

11. We say that a tightened chalk line forms a straight line. It doesn't. We say the surface of a still lake is flat and that a line laid across it is straight. It isn't. But these approximate the straight lines in our practical world. A much better approximation, however, is a beam of light. For distances used by surveyors, a beam of light is the best approximation of a straight line known. Yet we know that a laser beam is ever-so-slightly deflected by gravity. In actual practice, however, we say that a laser beam of light *defines* a straight line.

16. The clock will run slower at the bottom of a deep well than at the surface, because in going down the well, we are moving in the direction that the gravitational force acts, and this results in a slowing of clocks. However, this would only be a slowing down as viewed from above, at the top of the well. If we went with it, we would notice no change as compared with ourselves, our wristwatch, etc.

18. The light will be red-shifted. The accelerating car is equivalent to a stationary car standing vertically with its rear end down. The light going from the back to the front of the accelerating car behaves just like light going upward away from the surface of a planet. It is gravitationally red-shifted. (If your friend were moving toward you, it would be a different story. Then the Doppler effect arising from your relative motion would produce a blue-shift. But in this example, with no relative motion, there is no Doppler effect. Only the effect of gravity – or equivalent acceleration – remains.)